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FINAL REPORT TO OFFICE OF NAVAL RESEARCH

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Modification of ROST System

Final Report

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Laboratory Testing

The Remote Optical Settling Tube (ROST) system was tested extensively in a tank at Sea Tech during October and November of 1988. Initial tests revealed that in a moderately turbulent environment the original lids to the settling tube did not seal well enough to prevent the infiltration of sediment particles into the tube when the lids were closed. The sealing surfaces of the lids were re-worked to eliminate this problem. After reworking, the ROST showed no evidence of particle infiltration (Figure 1.).

Further tests revealed that particles settling out in one sample run could be trapped on the lower lid of the settling tube. These particles would then be re-suspended inside the settling tube when the lids were closed for the next settling interval (figure 2.). This problem was alleviated in part by cycling the lids twice between sampling intervals. The first lid closing cycle acted to flush most of the particles from the lid surfaces. The settling tube was then left open for one hour to allow the re-suspended sediment to be flushed away and the interior of the tube to return to equilibrium with the surrounding water mass.

Once these mechanical and sequencing problems were resolved, several further tests showed less problem with sediment re-suspension. However, the current lid-closing design of the ROST system causes a great deal of turbulence both inside and outside the tube when the lids close. The possibility of re-suspension of sediments from previous tests still exists. Since the re-suspended sediments are not uniformly mixed throughout the settling volume, they may cause "bumps" in the settling profiles. Such "bumps" are a prominent feature in the plots of data collected in the laboratory (figures 3 and 4). Adding internal baffles to the ROST in an attempt to minimize internal turbulence and the formation of convection cells actually caused an increase in the "noise" in the settling profiles. (figure 5.).

Additional laboratory experiments showed that the ROST system may also behave in an abnormal manner due to mechanical energy transmitted through the walls of the tube enclosure. This mechanical energy is a result of turbulent flow around the ROST system. In the test tank this flow is a result of the circulating pumps of the test tank. In the field, such flow would result from currents and wave action. This energy input may cause re-suspension of particles from the bottom of the tube. When the test tank pumps were shut off, the settling profiles were definitely smoother (figures 3 and 6.). Despite these unresolved technical questions, in its present form it is still possible to obtain useful results from the ROST. For a discussion of data analysis see Spinrad *et al* (1985).

Field Deployment

The ROST system was deployed in the Pacific Ocean off the Northern California Coast in December of 1989. The ROST was attached to a tripod provided by Woods Hole Oceanographic Institution as part of the STRESS experiment. The operation of the ROST, its controller, and recorder were monitored by Sea Tech personnel during the first three days of the deployment cruise. The tripod was deployed in 90m of water off the mouth of the Russian River approximately 60 nanometers North of the mouth of San Francisco Bay. The tripod was deployed by allowing it to free-fall to the bottom on December 5, 1988. Due to a problem with other instruments on the tripod, it was retrieved and re-deployed on December 7, 1988. During this retrieval and deployment, no Sea-Tech personnel were aboard the research vessel to verify the condition and operation of the ROST system.

The ABSS tripod to which the ROST was attached was scheduled for retrieval on January 24, 1989. Recovery attempts at this time failed due to problems with the mechanism used to release the recovery buoy. The tripod was subsequently retrieved on March 22, 1989 with the aid of a remotely operated vehicle. Upon examination by Sea Tech on March 23, 1989, the ROST data recorder was found to have dead batteries and no data was recovered. The mechanical position of the ROST doors indicated that either the data recorder or the door-opening system may have failed at the time of the second deployment in December. The failure was most likely a result of mechanical or electronic failure resulting from vibration

and impact stresses resulting from the free-fall deployment and retrieval cycles of 4-7 December.

Laboratory testing of the ROST system after its return to Corvallis and replacement of the data recorder batteries did not reveal any problems with the recorder software or ROST hardware. The software used for the test was the same software which had functioned continuously for the 5 days prior to the first deployment and was used during the deployment. Since no estimate of the magnitude of vibration and shock stresses occurring during the deployments are available, Sea Tech has not attempted to duplicate these stresses.

An examination of the Spinrad paper in combination with the improved mechanical design and cycling of the system, would seem to indicate that results superior to those reported by Spinrad could have been obtained during the STRESS experiment. It would be unfortunate if failure of the tripod retrieval system which in itself is unrelated to ROST would prevent further *in-situ* testing of the ROST system.

It would be of considerable interest to compare size distributions obtained by ROST with measurements of spectral attenuation *in-situ*. A spectral attenuation meter is under development at Sea Tech Inc.. Its data can be inverted to obtain particulate size distributions (Kitchen, 1982) Simultaneous long-term deployment of both instruments would allow greatly improved understanding of the temporal variation of the particle size distribution and best ways of monitoring these.

Bibliography

Spinrad, R.W., R. Bartz, and J.R.V. Zaneveld, In Situ Measurements of Marine Particle Settling Velocity and Size Distributions Using the Remote Optical Settling Tube. J. Geophys. Res., 94, 931-938, 1989.

Kitchen, J. C., J. R. V. Zaneveld, and H. Pak, Effect of Particle Size Distribution and Cholorphyll Content on Beam Attenuation Spectra. Applied Optics, Vol. 21, 3913-3918, 1982.

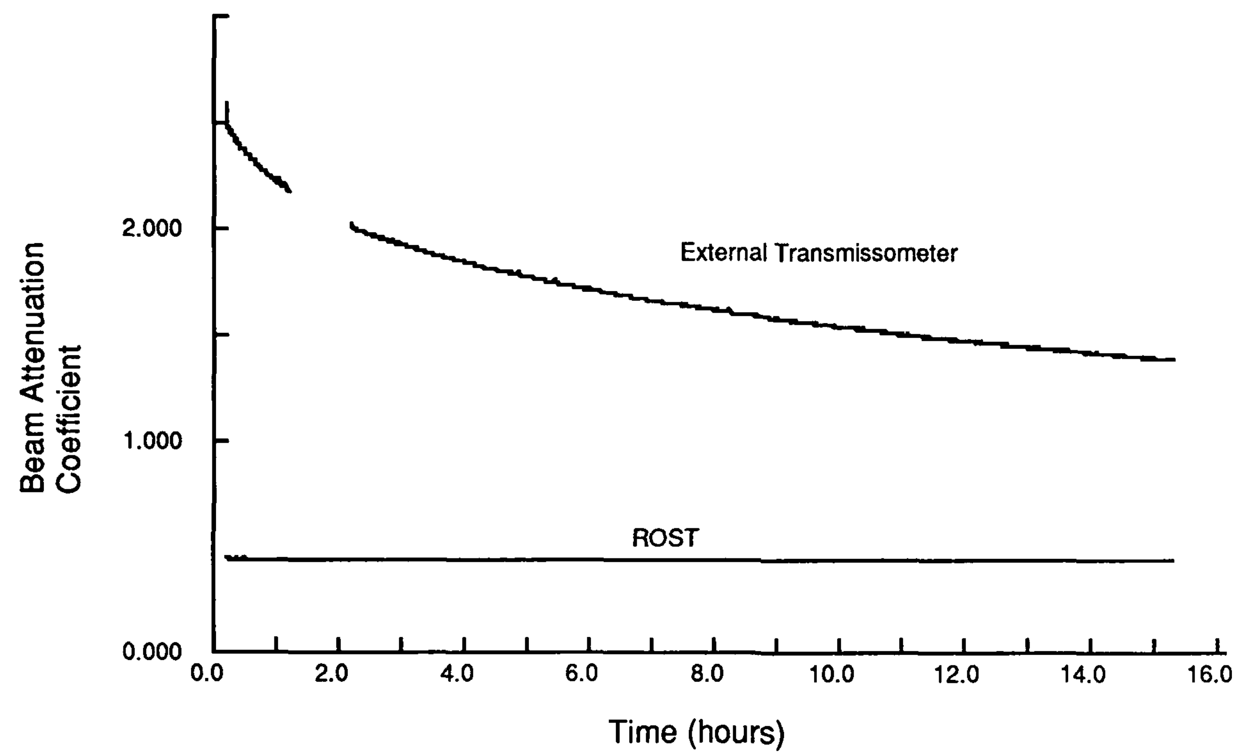

Figure 1. In this experiment, ROST was sealed with clean water inside. Sediment was added to the tank to test for infiltration of particles into the ROST. The gap in the external transmissometer data occurred when it was removed for use in calibrating other instruments.

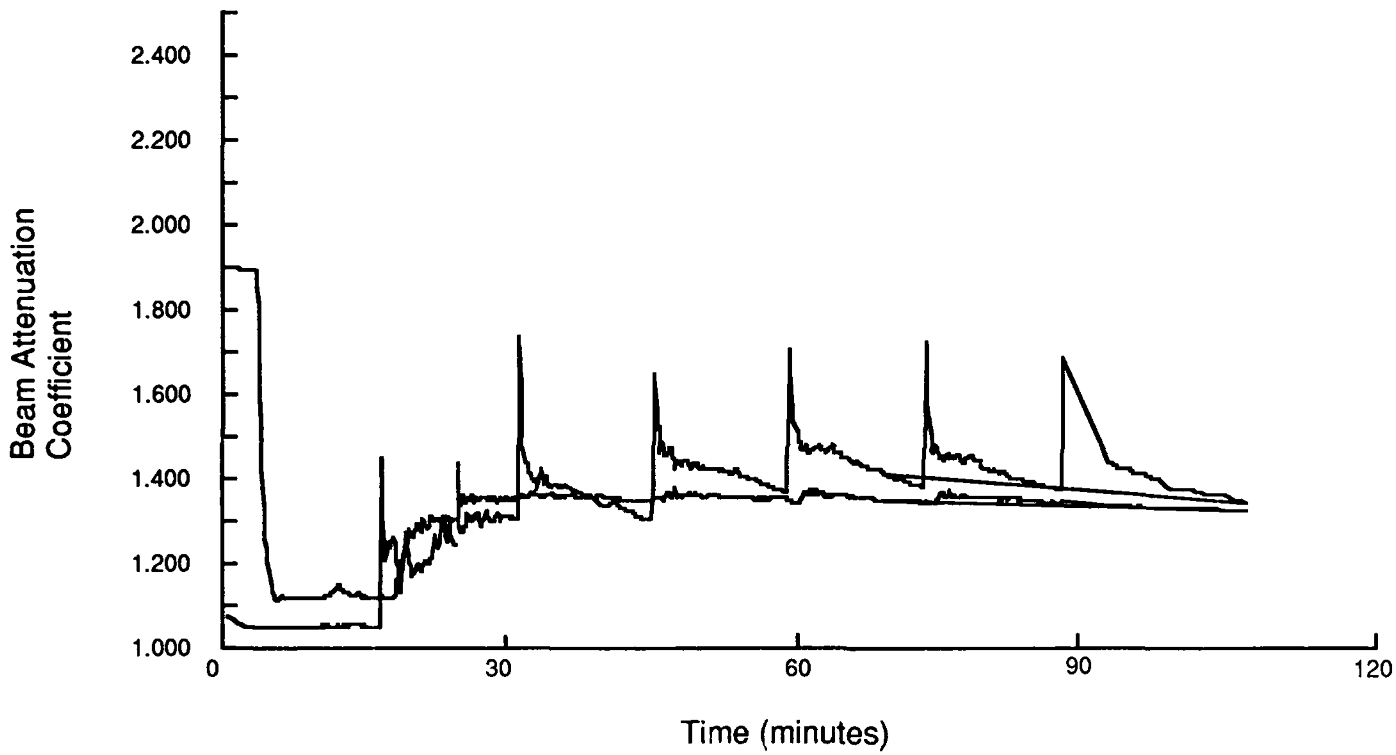

Figure 2. In this test the ROST lids were cycled at 15-minute intervals. The peaks result when sediment setting on the ROST lids is re-suspended inside the ROST. The smaller peaks in the external transmissometer reading show that sediment in the tank is also being re-suspended.

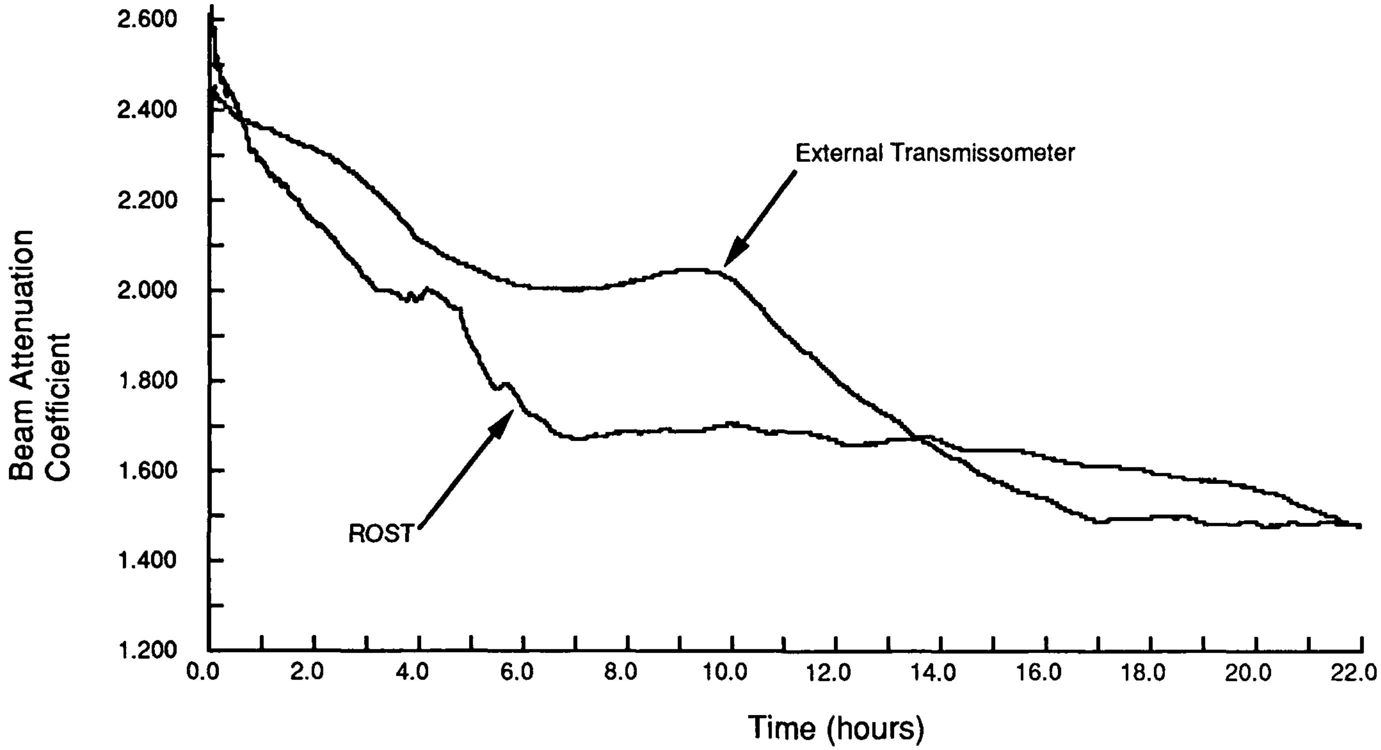

Figure 3. This test was conducted in the salt-water tank with the circulating pump turned off. The bump in the external transmissometer readings is probably due to incomplete mixing of the sediment in the tank.

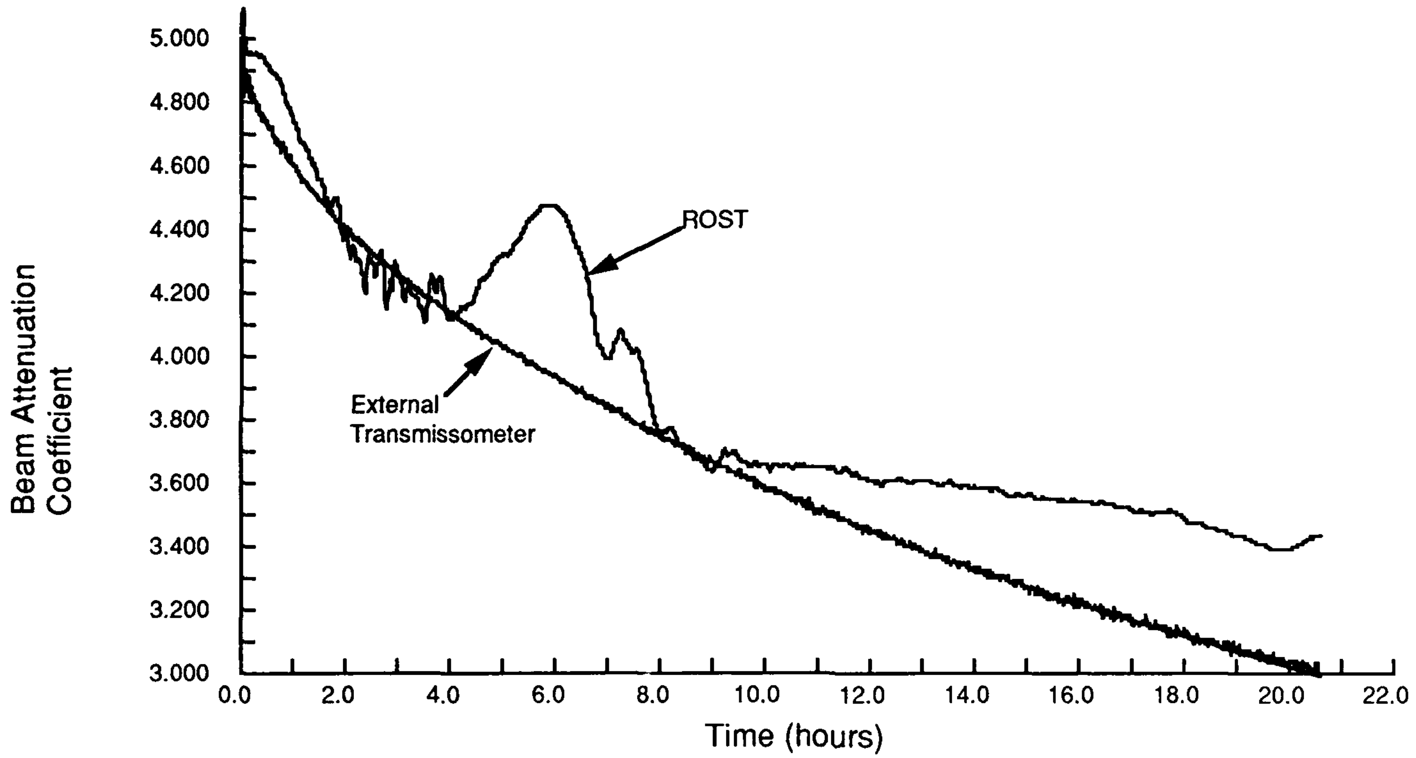

Figure 4. This test was conducted with a very high initial sediment load in the tank. The ROST lids were cycled one hour before the data collection started.

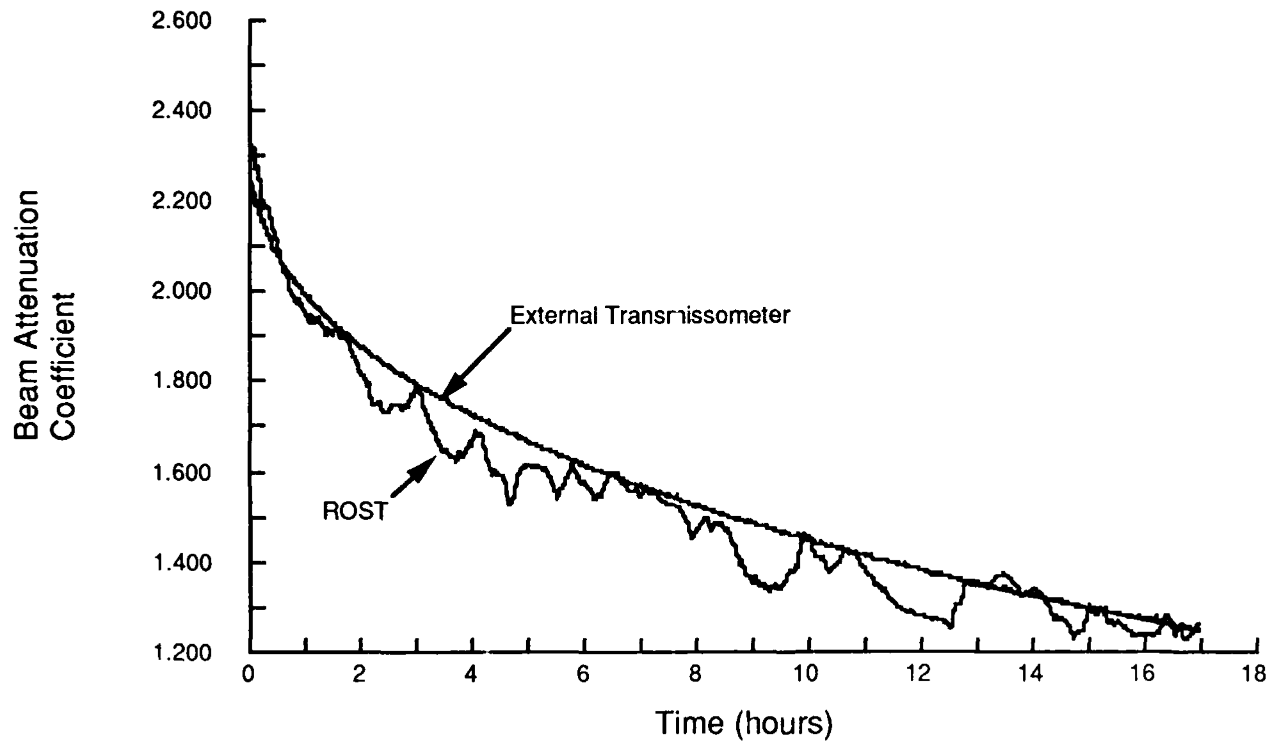

Figure 5. This settling test was conducted with plastic baffles inside the ROST in an attempt tc minimize disturbances due to convection cell formation inside the enciosure.

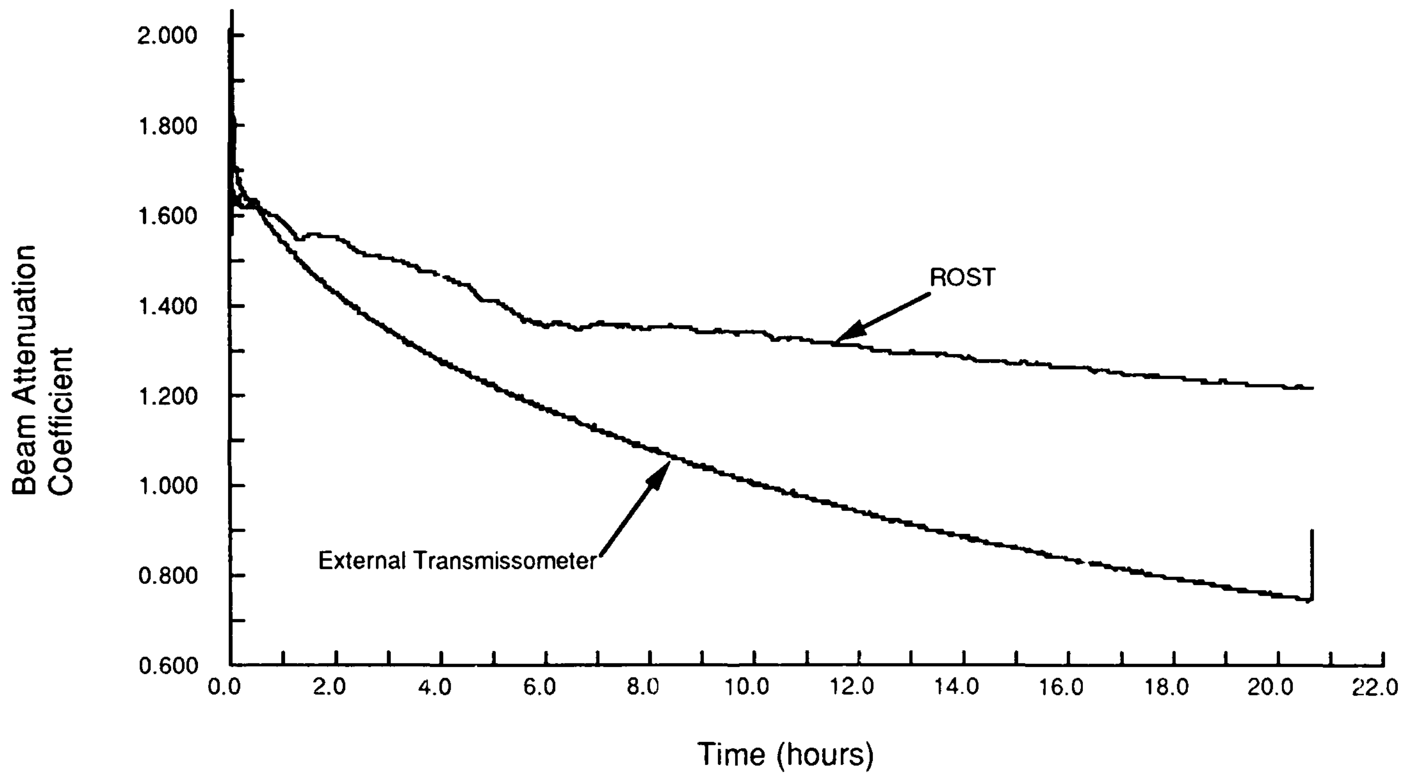

Figure 6. Another settling test with the mud re-suspended from the bottom of the test tank. Many of the larger particles were probably not completely re-suspended.